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Fishery and population dynamics of the obtuse barracuda *Sphyraena obtusata* (Cuvier) landed by trawlers at Cochin, south-west coast of India

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ABSTRACT

Fishery and population characteristics of the obtuse barracuda *Sphyraena obtusata* (Cuvier) landed by mechanised trawlers off Cochin were studied for the period 2010-2012. The average annual landings of barracuda was 184 t of which *S. obtusata* formed 65%. Seasonal peak in catch and catch rate was recorded during August, followed by February and May. The von Bertalanffy growth parameters (VBGF) estimated using ELEFAN were L_∞ = 34.2 cm, K = 0.71 year^{-1} and t_0 = -0.0000000025. The lengths attained at the end of 1, 2, 3, 4 and 5 years were 17.4, 25.9, 30.1, 32.2 and 33.2 cm, respectively. Recruitment was almost round the year with a major peak during February-May and a minor peak during July, together accounting 80% of the total recruitment. Natural mortality (M), fishing mortality (F) and total mortality (Z) were 1.35, 1.54 and 2.89 respectively. The length at first capture was 23.5 cm (age 1.64 years). The optimum length for exploitation (L_{opt}) was 20.9 cm at the age of (t_{opt}) of 1.3 years. Mean size in the catch (25.1 cm) was higher than L_{opt}. The resource is being exploited at a level marginally higher than E_{50} (E = 0.53), indicating optimal exploitation. Though the annual average yield is only marginally (6%) higher than the MSY estimated, there is no need for reducing the fishing effort from the prevailing rate. Instead, as the yield and biomass per recruit and yield and biomass curves showed that the maximum yield and yield per recruit could be obtained by increasing the present level of fishing, marginal increase in the effort is prescribed to sustain the fishery.

Keywords: Barracuda, Exploitation, Growth, *Sphyraena obtusata,* Stock assessment, Trawl catches

Introduction

Barracudas are a commercially important group of fishes landed along the south-west coast of India. These are sold fresh, frozen or dried in local as well as export markets. The average annual landings of barracuda in Kerala during 2002-2012 was 4,288 t, which formed 1% of the total landings of the state. They are exploited by a number of fishing gears including mechanised trawlers, gillnets and outboard ringseines. The obtuse barracuda *Sphyraena obtusata* (Cuvier) is one among the smaller and commercially important species of barracudas which contribute more than 50% of barracuda landings by trawlers in the state.

In spite of the commercial importance of barracudas along Indian coast, there are only few reports on its biology and taxonomy including those of Jones and Kumaran (1968), Kothare (1973) and Pillai (1981). There is also some information on length-weight relationship and morphometry of *S. obtusata* from Bombay waters along north-west coast of India (Jaiswar *et al.,* 2004) and from Sri Lankan waters (Shivasanthini *et al*., 2009). However, information on age and growth, exploitation pattern and stock assessment of this species is scanty. The only available literature on population dynamics of this species from Indian waters are limited to the east coast of India (Somavanshi,1989; Kasim and Balasubramaniam, 1990). There is no published information available on the stock structure and population dynamics of this species from west coast. The present study is, therefore aimed at investigating the age and growth, exploitation pattern and stock status of *S. obtusata* caught by trawlers along Cochin, south-west coast of India.

Materials and methods

Data on catch and effort expended for *S. obtusata* and species composition of barracudas were collected fortnightly from the trawl landings of Cochin Fisheries Harbour during January 2010 to December 2012. To describe the fishery, monthly and annual estimates of catch were made following the stratified multistage random sampling procedure adopted by Fishery Resource Assessment Division of Central Marine Fisheries Research Institute (CMFRI), and raised to the centre as well as state catch. A total of 812 fishes in the length range of 16.5-34.5 cm in total length were used for the estimation of growth parameters. Data on length, weight, sex and stages of maturity in females were also recorded.

The von Bertalanffy growth parameters *viz.,* asymptotic length (L_∞) and growth rate (K), were estimated by pooling the length measurement data (cm) of two years month-wise and then grouped to form length frequency data with 1 cm class interval. The growth parameters were estimated using ELEFAN module of FiSAT software (Gayanilo *et al.,* 1996). Growth performance index φ was calculated from the final estimates of L_∞ and K (Pauly and Munro, 1984). Length corresponding to the first value in the descending limb of the length converted catch curve was taken as the length at first capture (L_c). The age at zero length (t_0) was estimated from Pauly's (1979) empirical equation, Log ($-t_0$) = - 0.392 - 0.275 Log L_∞ - 1.038K. Natural mortality (M) was estimated using Pauly's empirical formula (Pauly, 1980), using 27°C as the mean sea temperature. Total mortality (Z) and exploitation rate (E) were estimated from the catch curve and exploitation ratio (U) from the relation $U = F/Z_*(1-e^{-Z})$; where, F is the fishing mortality (Pauly, 1983a).

Midpoint of the smallest length group in the catch was taken as length at recruitment (L_r). Relative yield per recruit (Y'/R) and biomass per recruit (B'/R) at different levels of F were estimated using LFSA package (Sparre, 1987). The L_c value was converted to t_c value using the inverse von Bertalanffy growth equation. E_{max} was estimated graphically (Corten, 1974). Longevity, t_{max} was estimated from t_0 using the formula $t_{max} = t_0+3/k$ (Pauly 1983b). Length of maximum possible yield in the fishery was calculated following Beverton (1992), as: $Lopt=L_\infty*[3/(3+M/K)]$

Total annual stock (P) and standing stock biomass (B) were estimated from the ratios Y/U and Y/F respectively; where, Y is the annual average yield of the species in tonnes and U, the exploitation ratio. Maximum sustainable yield (MSY) of *S. obtusata* was estimated by the equation MSY = Z*0.5*B for exploited fish stocks (Gulland, 1979). Length structured virtual population analysis was used to obtain fishing mortalities per length class. Yield (Y) and Biomass (B) at different fishing levels were predicted by length based Thompson and Bell model (Thompson and Bell, 1934).

Results and discussion

Fishery

The annual average landing of barracuda along Kerala coast was 4,288 t contributing about 1% to the total landings of Kerala. The catch increased gradually from 3,591 t in 2002 and reached the highest landing of 5,129 t in 2009. Thereafter it declined gradually to 3,673 t in 2012 (Fig. 1).

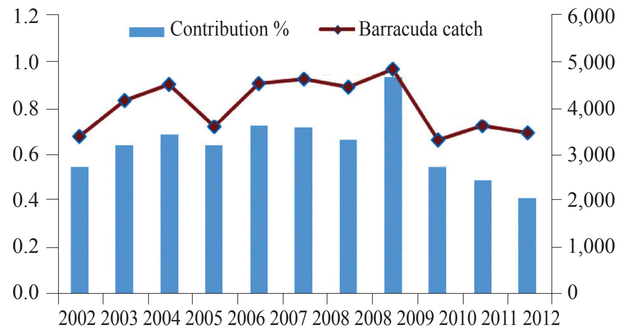

Fig. 1. Trend in the annual landings of barracuda (t) and its contribution (%) to total catch in Kerala during 2002-2012

A recent study conducted by Vivekanandan *et al.* (2010) on the trawl landings along the coast indicated that catch and catch rate of small pelagics were increasing over the last decade while high value resources such as penaeid shrimps and cephalopods registered low catch and catch rates. Barracudas, especially the smaller species such as *S. obtusata* and *S. forsteri* being small pelagic fishes, contributed a small fraction to the increase in landings of small pelagic assemblages in trawls during the period. The annual average landings of barracuda at Cochin during 2010-12 period was 184 t with a catch rate of 0.5 kg h^{-1}. Seasonal abundance of the resource indicated that the peak landings of 48.8 t was in the post-monsoon month of August, immediately after the trawl ban, which is followed by May and February months (Fig. 2). Catch rate was highest during August followed by May and November. Of the 184 t of annual landings, *S. obtusata* contributed 120 t.

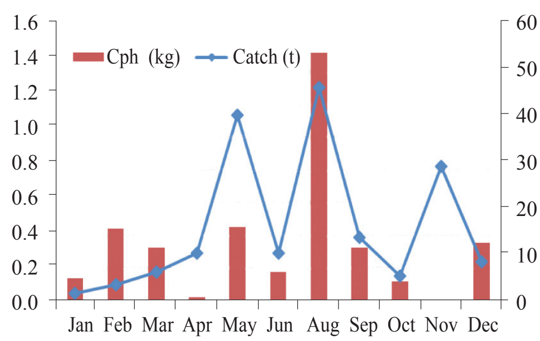

Fig. 2. Seasonal abundance of barracudas landed in trawls off Cochin

Species composition

Barracuda fishery off Cochin was supported by four species during 2010-2012 (Fig. 3). *S. obtusata* dominated the fishery with a contribution of 64.8% followed by *S. forsteri* (23.8%) and *S. jello* (9%). A small fraction (2.4%) of *S. barracuda* was also landed by trawlnets during the period. Dominance of *S. obtusata* (69.6%) was also observed in the trawl landings along the south-east coast of India by Kasim and Balasubramanian (1990), where they reported another species *S. picuda* in the landings.

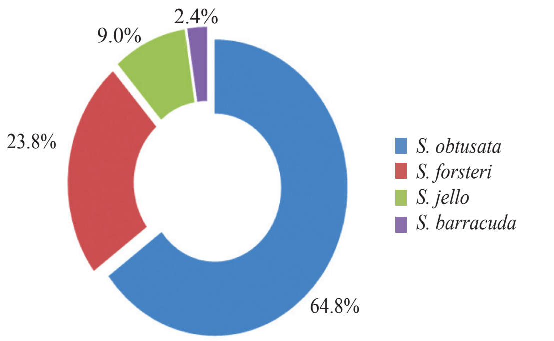

Fig. 3. Species composition of barracuda landed in mechanised trawlers at Cochin

Length composition

The mean length of *S. obtusata* landed during 2010-2012 period at Cochin varied between 21.9 and 26.4 cm. Higher mean lengths were recorded during February to March and in September and October. The lowest mean length recorded was in August, immediately after the seasonal trawl ban when peak landing of *S. obtusata* was recorded (Fig. 4). Shivasanthini *et al.* (2009) reported the length range of *S. obtusata* caught from Jaffna Lagoon as 14.0-33.4 cm with a mean length of 21.9 cm. Jaiswar *et al.* (2004) reported a higher length range of 17.3-43.5 cm for the species landed along Bombay.

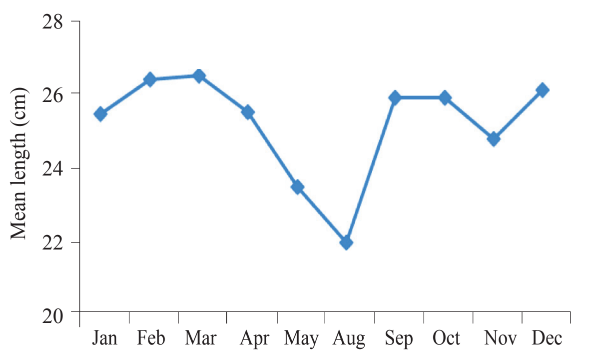

Fig. 4. Average monthly mean length of *S. obtusata* landed by trawlers off Cochin

The von Bertalanffy growth formula (VBGF) derived for *S. obtusata* using ELEFAN was $L_t = 34.2\ [1-e^{-0.71(t + 0.00000000025)}]$. The growth performance index φ was found to be 2.92. The lengths attained by *S. obtusata* at the end of 1, 2, 3, 4 and 5 years were 17.4, 25.9, 30.1, 32.2 and 33.2 cm, respectively. Kasim and Balasubramanian (1990) recorded K as 1.02 year^{-1} for *S. obtusata* caught by trawls along the south-east coast of India. However, Somavanshi (1989) reported a 'K' value of 0.54 year^{-1} from exploratory trawl survey data collected from the same region. The present estimate of K as 0.71 year^{-1} is higher than that reported by Somavanshi (1989). Such regional differences in growth rate are common among the same species of exploited resources. Kasim and Balasubramanian (1990) attributed the difference in estimates to the sample strength and size. The L_∞ obtained during the present study is lower when compared to the earlier estimates (Somavanshi, 1989; Kasim and Balasubramanian, 1990) reported from the south-east coast of India.

The average instantaneous rate of total, natural and fishing mortalities were 2.8, 1.3 and 1.54 y^{-1} respectively (Fig. 5). The exploitation rate E was 0.53 and the exploitation ratio U was calculated at 0.56. Exploitation of *S. obtusata* along south-west coast of India is optimum, as evident from the values of E and U obtained in the present study. The natural and total mortality rate estimates for the present study are similar to those reported by Kasim and Balasubramanian (1990). Their estimates of natural and total mortality rates were 1.59 and 2.83 respectively, which were higher when compared to the values of 1.0 and 2.24 respectively reported by Somavanshi (1989).

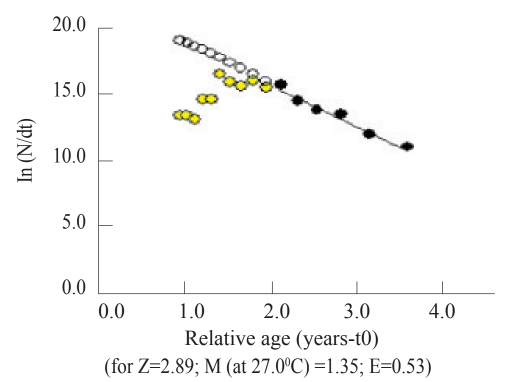

Fig. 5. Length converted catch curve for *S. obtusata* landed in trawlers off Cochin during 2010-2012

The optimum length for exploitation (L_{opt}) obtained during the present study was 20.93 cm at the age of (t_{opt}) of 1.33 years. Length at first capture was 23.5 cm at age of 1.64 years. In the present study, the E is almost equal to the optimum level of exploitation. However, E_{max}, which gives maximum yield for the species is 0.925, which is larger than the exploitation rate throughout the period. This indicates that there is scope for improving production. Production can be increased marginally by increasing the effort input, but with constant monitoring of the stock.

Recruitment pattern

The recruitment pattern observed for *S. obtusata* at Cochin was bimodal with the major peak during February-May period, when almost 67% of the total annual recruitment occurred (Fig. 6). There was another minor peak during July with about 13% of the annual recruitment. As most of the recruitment happens during February-May, there is a chance for juvenile fishing during

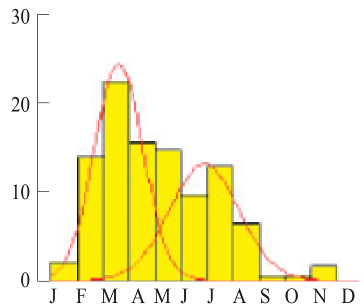

Fig. 6. Recruitment pattern of *S. obtusata* at Cochin

the monsoon period as well as in the month immediately after the trawl ban. The smallest fish which suffered mortality by trawl net measured 16.5 cm which is taken as the size at recruitment and the corresponding age at recruitment is calculated at 0.93 year. Along the east coast of India, the size and age at recruitment for *S. obtusata* reported by Kasim and Balasubrahmanian (1990) was 10 cm and 0.22 year respectively, which is much lower than that obtained during the present study.

Estimation of stock and MSY

The estimated average annual landings of barracudas by trawlnets at Cochin was 184 t, of which about 120 t was *S. obtusata*. The annual average standing stock was estimated at 214 t and the biomass was estimated at 78 t using the formula B = F/Z. The MSY estimated for *S. obtusata* from the biomass and total mortality rate was about 113 t.

Yield and yield per recruit

The yield and biomass per recruit and yield and biomass curves showed that the maximum yield and yield per recruit could be obtained by increasing the present level of fishing by 100% (Fig. 7 and 8). The maximum yield and yield per recruit obtained at 200% of the present fishing effort is 144.0 t and 24.4 g, whereas at the present level of fishing, it is only 120 t and 20.3 g. The biomass and biomass per recruit achieved at 200% of the present effort is 46.9 t and 7.9 g, respectively but with the present rate, the biomass and biomass per recruit are high (77.9 t and 13.2 g respectively). The relative yield would be 120.2% at the increased effort.

Yield (Y) and biomass (B) at different fishing levels, predicted using length based Thompson and Bell model, shows that the yield increases when the effort from the current level increases to certain level, but thereafter the increase in yield is marginal with increase in fishing effort. If the fishing effort is increased by 100%, the yield increase is only 20% initially. Thereafter, the increase in yield is very low with increase in effort, which is not economically feasible. Hence, based on the results of Thompson and Bell prediction model, only marginal increase in fishing effort is suggested for the optimum exploitation of the resource. Substantial increase in effort could result in overfishing of *S. obtusata* stock and the other resources which are harvested by the same gear.

The annual average yield of the species is only marginally higher (6%) than the MSY estimates. This implies that the stock is not under any kind of fishing pressure. Moreover, as the current age at first capture of this species is much higher than the optimum age of exploitation, there is no urgent need to reduce the fishing effort or to increase the age at first capture as the fishery is exposed to lower fishing pressure presently. Instead, the yield and biomass per recruit and yield and biomass curves showed that the maximum yield and yield per recruit could be obtained by increasing the present level of fishing. However since at 200% of the present level of fishing, there would be a tremendous fishing pressure and as the MSY estimated is 6% lower than the present yield, only marginal increase in the effort is prescribed to sustain the fishery. As *S. obtusata* is landed in trawlnet along with many other resources, the stock status and trend in exploitation of those commercially important resources should also be considered while arriving at a conclusion to increase the effort.

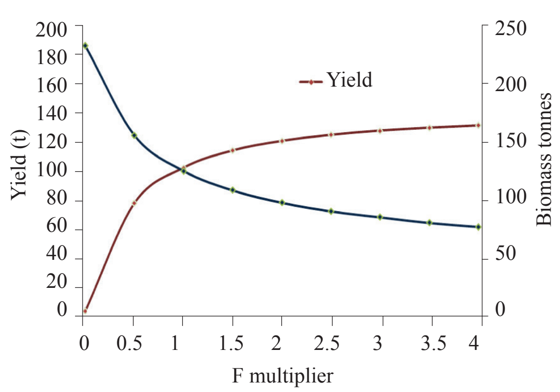

Fig. 7. Yield and biomass obtained for *S. obtusata* for different multiples of F using Thompson and Bell Prediction model

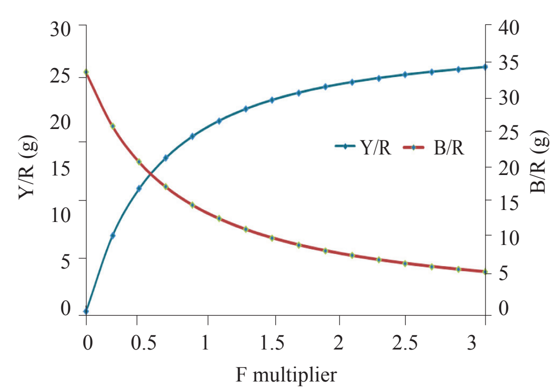

Fig. 8. Yield per recruit and biomass per recruit of *S. obtusata* for different multiples of F

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